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Effects of *In-utero* Heat Stress on Porcine Post-natal Thermoregulation

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Summary and Implications

Pigs were exposed to heat stress (HS) and thermoneutral (TN) conditions *in-utero*. Post-natally, they were exposed to either TN or HS environments for 15 days, and differences in physiological response comparing *in-utero* treatment groups were determined. Our results indicated that gestational HS (GHS) pigs had increased core body temperature during post-natal HS compared to pigs exposed to gestational TN (GTN); however, there were no production differences between gestational groups. This provides evidence suggesting pigs exposed to *in-utero* HS may have an increased tolerance to post-natal HS, at least from a productivity standpoint.

Introduction

Heat stress negatively impacts health and production variables in almost all livestock industries. Despite aggressive HS abatement strategies, the U.S. swine industry loses >$300 million annually because of HS-related issues These economic losses can be traced to heat stress during fetal development and post-natal life that negatively affects growth, reproductive performance, and carcass quality.

The effects of HS on the aforementioned post-natal variables are well-established; however, the extent to which environmental hyperthermia experienced by pregnant sows affects future phenotypic traits in their progeny is currently unknown. One trait that may be epigenetically altered is the ability to maintain euthermia during post-natally stressful conditions. Although the beneficial effects of pre-natal HS have been demonstrated in poultry, the relationship between gestational HS and post-natal heat tolerance in mammals is not well described.

Materials and Methods

Pregnant sows were exposed to TN (constant 19 - 22°C; 65% RH; n = 12), or HS (cyclic 28 - 38°C; 67.5% RH; n = 13) conditions at the University of Missouri. Resultant offspring were transported to Iowa State University. Pigs from GTN (n = 12; 73.0 ± 1.5 kg BW), and GHS (n = 12; 69.7 ± 1.1 kg BW) sows were housed in individual pens in either TN (n = 6 GTN, 6 GHS; 22.7 ± 2.5°C) or HS (n = 6 GTN, 6 GHS; 34.7 ± 2.3°C) conditions (Fig 1). Throughout post-natal heat exposure, rectal temperature (T_{re}) and respiration rate (RR) were monitored four times daily, as fed feed intake (FI) was determined on d 7 and 15, and body weight (BW) was determined on d -1, 7, and 15.

Results and Discussion

Pigs exposed to both HS and TN conditions *in-utero* had an increase in T_{re} (Fig.2A) during HS compared to post-natal TN conditions. Gestationally heat-stressed pigs had significantly higher T_{re} compared to GTN pigs within the post-natal HS room (Fig. 2A). However, despite the higher T_{re}, no increase in RR occurred for GHS pigs compared to GTN pigs (Fig. 2B). Regardless of the elevation in T_{re} observed for GHS pigs in post-natal HS conditions, no production trait differences occurred comparing gestational thermal treatments (Table 1).

Despite the increase in rectal temperature in response to post-natal HS, pigs derived from *in-utero* HS had similar productive parameters compared to thermoneutral control animals. Our results suggest that *in-utero* HS allows for superior tolerance (maintenance of productivity) to post-natal hyperthermia. Although our interpretation needs confirming, it is tempting to speculate that a portion of this altered phenotypic response is due to epigenetic imprinting.

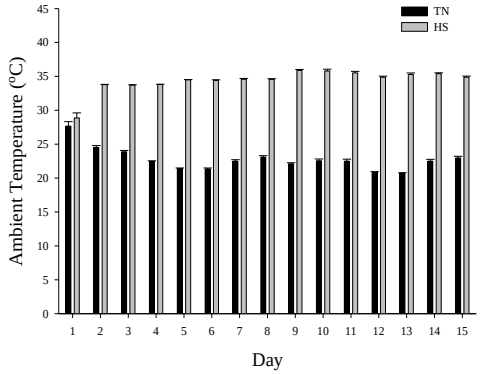

Figure 1: Ambient temperature (T_a) in the thermoneutral (TN) and heat stress (HS) conditions.

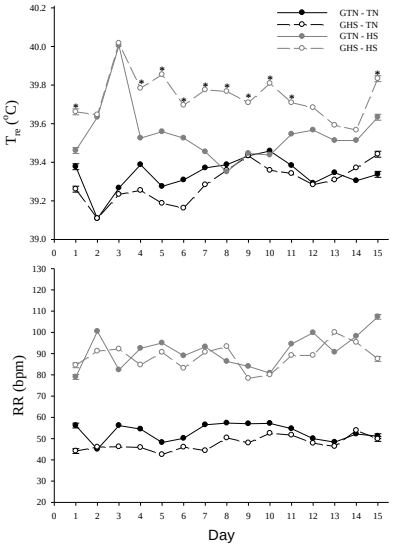

Figure 2: Effects of gestational and post-natal thermal environments on the temporal changes in (A) rectal temperature (T_{re}) and (B) respiration rates (RR) in growing pigs. Gestational heat stress = GHS, gestational thermoneutrality = GTN, post-natal thermoneutral conditions = TN, post-natal heat stress conditions = HS. Error bars on d1 and d15 of the line indicate ± 1 SEM. * indicates $P < 0.05$ between GHS –HS and GTN – HS treatments.

Table 1. Effects of gestational and post-natal thermal environments on production parameters in growing pigs.

	Environments					*P*		
Parameter	GTN-TN[1]	GHS-TN[2]	GTN-HS[3]	GHS-HS[4]	SEM	G[5]	P[6]	G x P
FI (kg/d)[8]	2.86	2.88	2.20	2.09	0.10	0.65	<0.01	0.54
ADG (kg/d)[7]	1.07	0.91	0.77	0.65	0.15	0.36	0.07	0.89
Gain:Feed (kg/kg)[9]	0.38	0.30	0.35	0.27	0.10	0.23	0.59	0.95

[1]Gestational thermoneutral pigs in thermoneutral conditions
[2]Gestational heat stress pigs in heat stress conditions
[3]Gestational thermoneutral pigs in heat stress conditions
[4]Gestational heat stress pigs in heat stress conditions
[5]Gestational environment
[6]Post-natal environment
[7]Average daily gain
[8]Feed intake
[9]Feed efficiency